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### Cloud Ice Radiometry at Submillimeter-Wavelengths

Submillimeter cloud ice radiometry is a new technique for characterizing and monitoring the properties of upper-tropospheric ice clouds. Passive radiometric measurements at submillimeter-wavelength (frequencies above 300 GHz) can be used to retrieve integrated ice mass, determine the median crystal size, and constrain crystal shape. Developing a technique to obtain quantitative global observations of ice clouds is a high priority for the climate modeling community.

Submillimeter cloud ice radiometry can be understood intuitively. When viewed from space, water vapor in the lower troposphere emits a relatively uniform background of submillimeter-wavelength radiation. When cirrus clouds are present, they scatter the upwelling flux of submillimeter-wavelength radiation, thus reducing the upward flux of energy. Hence, the power received by a nadir-viewing radiometer decreases when a cirrus cloud passes through the field of view. The reduction in brightness temperature is a function of the amount and size of the scatterers. Radiometric measurements made at multiple frequencies will permit brightness temperature variations caused by changes in mean crystal size to be distinguished from variations in ice content. Particle shape can be constrained with measurements at orthogonal polarizations.

In the fall of 1996, a proof-of-concept radiometer flew on the NASA DC-8. It successfully observed a band of cirrus at 500 GHz and 630 GHz. These measurements tested basic concepts and established technical feasibility. Development of a dedicated, four-frequency, airborne submillimeter-wavelength radiometer is underway to validate the radiometric retrieval cloud properties and support airborne science programs. Simulations of instrument performance indicate that the radiometer will be able to accurately measure cloud ice mass for ice water paths above 20 g/m<sup>2</sup> and median mass diameters above 150 microns. Successful validation will demonstrate the maturity of submillimeter-wave cloud ice radiometry and facilitate the adoption of spaceborne cloud ice radiometry to investigate and monitor cirrus on a global scale. This would represent a major breakthrough for climate modeling by providing observations needed to validate models of global climate and atmospheric hydrology.